Nuclear Physics Ch 30-31

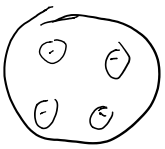
Atom - word comes from the ancient Greek word for indivisible.

Ancient Greece Democritus hypothesized that everything is small indivisible particles in a vacuum.

Aristotle - everything is Earth/air/fire/water.

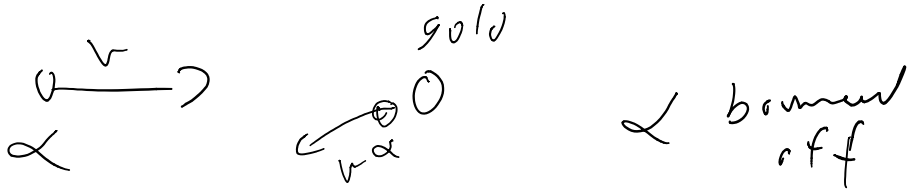
Dalton - chemical reactions are combining elements together in certain ratios.

Thompson - 1890s - discovered the electron. hypothesized the plum pudding model.



Rutherford- gold foil experiment. Alpha particles - helium nucleus- bounced off very thin gold foil.

evidence for the nucleus - dense and positive



bohr - electron energy states are quantized. Light is created when electrons jump down energy states - from high energy orbitals to low energy.

Heisenberg and Schrodinger - particles can't be observed without altering their states. Wave properties - probability wave.

Chadwick - discovered the neutron.

nucleus:
Element- determined by the number of protons in the nucleus.

Isotope- same number of protons but different number of neutrons.

eg. Hydrogen has 1 proton, $^{1}_{1}H$

deuterium has 1 proton and 1 neutron $^{2}_{1}H$

tritium has 1 proton and 2 neutrons $^{3}_{1}H$

Ion - atom that loses or gains electrons. H^{+}

Nuclear Radiation - when the nucleus is unstable and gives off something.

alpha, beta and gamma radiation are common

gamma - most penetration - goes through some lead shielding

electromagnetic radiation with high energy photons
- bundle of energy - like light but more energy per bundle and higher frequency, short wavelength.

Doesn't change the atomic number or mass number.

eg. cobalt 57 emits gamma radiation

$$^{57}_{27}Co \rightarrow {}^{57}_{27}Co + {}^{0}_{0}\gamma$$

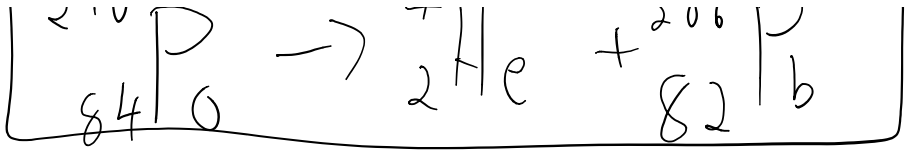
gamma

Alpha decay - least penetration- most mass

helium nucleus emitted from the nucleus

eg. polonium 210 emits an alpha particle. Draw the decay equation: (atomic number 84)

$$^{210}_{84}Po \rightarrow {}^{4}_{2}He + {}^{206}_{82}Pb$$

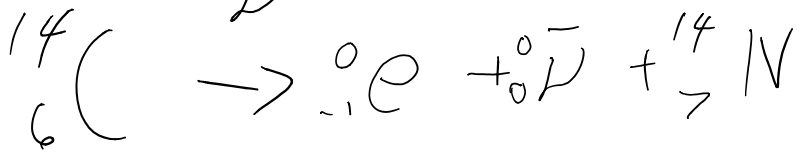


beta decay - penetrates more than alpha but less than gamma.

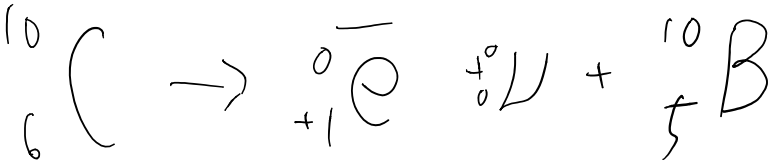
2 types: beta negative - electron and anti-neutrino produced in the nucleus from a neutron changing into a proton.
beta positive - positron (anti matter electron) and a neutrino produced from a proton changing into a neutron.

anti-matter - like matter but with opposite charge and quantum numbers but same mass. Will annihilate - change into gamma rays- if it meets the matter pair. positrons annihilate if they meet an electron.

eg. carbon 14 (atomic number 6) decays by beta negative decay. Give the decay equation, include the anti-neutrino $\bar{\nu}$



carbon 10 decays by beta positive decay. give the decay equation, include the neutrino, ν.



p618 - 621 Q1-8
next class is the carnival - short class introduce half-life p622 q9-12
p624 CR 1.1-1.4

Final review - 688-709 ch 1-5,9-12,14-19,30,31 universal gravity, relativity

Nuclear Physics - Chapters 30 and 31

What do you remember about the nucleus?>

Has neutrons and protons.

atomic number is the number of protons and determines the element.

eg hydrogen has 1 proton, carbon has 6 protons, uranium has 92 protons

neutrons are in the nucleus, have no charge

isotopes - same element with different number of neutrons.

eg. deuterium, hydrogen with one neutron

hydrogen

deuterium

tritium

ions - atom that is charged - lost or gained electrons.

Nuclear Radiation - some nuclei are unstable and give off particles and energy to stabilize.

3 types of common nuclear radiation

alpha, beta gamma

gamma radiation - can penetrate lead (like our sample)
electromagnetic radiation (like light and microwaves) but very high energy per photon- high frequency short wavelength.

symbol γ $^{0}_{0}\gamma$

has no mass or charge

doesn't change the atom in the decay equation

eg. cobalt 57 (atomic number 27) gives off gamma radiation

a) how many neutrons in cobalt 57?
b) write the decay equation for cobalt 57 by gamma decay:

a) 57 = number of protons + neutrons
27 = number of protons
therefore 30 neutrons

b) $^{57}_{27}Co \rightarrow {}^{0}_{0}\gamma + {}^{57}_{27}Co$

Alpha decay - a helium 4 nucleus is emitted from the nucleus.
low penetration - blocked by paper or skin but still poisonous if you eat it.

eg. polonium 210 (atomic number 84) decays by alpha decay.
a) how many neutrons are in polonium 210?
b) give the decay equation
a) 126 neutrons
b) equation: $^{4}_{2}\alpha$ or

$^{210}_{84}Po \rightarrow {}^{4}_{2}He + {}^{206}_{82}Pb$

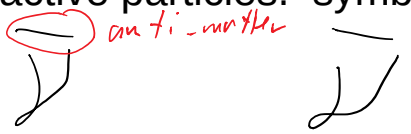
$^{84}_{}Po \rightarrow {}^{2}_{}He + {}^{821}_{}$

beta decay:
less penetration than gamma but more than alpha

2 types: beta negative and beta positive

both involve anti-matter
anti-matter is matter with opposite charge and quantum numbers but the same mass and energy
when anti-matter contacts corresponding matter, it annihilates - changes into energy - gamma rays.

beta negative decay- an electron and anti-neutrino are produced when a neutron changes into a proton.
neutrinos are highly unreactive particles. symbol
ν for neutrino and
$\bar{\nu}$ for anti-neutrino



beta positive decay - a positron (anti-electron) and neutrino are produced when a proton changes into a neutron.

eg. give the decay equations for carbon 14 (beta negative decay) and carbon 10 (beta positive).
Be sure to include the neutrino/anti-neutrino.

p618-621 q1-8
carnival - 9-12 and CR 1.1-1.4

$^{14}_{12}C \rightarrow {}^{-1}_{0}\nu + {}^{15}_{12}C$

$^{14}_{}C \rightarrow {}^{0}_{-1}\bar{\nu} + {}^{14}_{}N$

$$^{14}_{6}C \rightarrow {}^{0}_{-1}e + {}^{0}_{0}\bar{\nu} + {}^{14}_{7}N$$

$$^{10}_{6}C \rightarrow {}^{0}_{+1}e + {}^{0}_{0}\nu + {}^{10}_{5}B$$

Final p688 → 709

Ch 1-5, 9-12, 14-19, 30, 31

Gravity + Relativity